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Introduction Eventing is the equestrian sport in which horse and rider compete in each of the three individual disciplines – dressage, show jumping and cross-country. In Great Britain eventing competitions are graded – prenovice (P), novice (N), intermediate (I) and advanced (A). Genetic evaluations for eventing are rarely performed. Ideally, an evaluation would evaluate the individual grades of competition separately. Disciplines and grades could then be combined to give an overall evaluation, potentially allowing for different heritabilities and competition weightings. The objective of this study was to estimate the variances and covariances (3 matrices of 78 components, i.e. 234 components in total) required by industry for the prediction of breeding values for eventing.

Materials and methods
Eventing competition results were obtained from British Eventing. Competition results between 1999 and 2008 were analysed. Penalty points awarded for each discipline were transformed into a normal score for the competition class. Variance components for random effects (sire, horse's permanent environment and rider) were estimated, while allowing for the effect of fixed variables on the horse's performance. Horse sex, age (linear and quadratic covariates), and competition class were included as fixed effects. A sire model was implemented. This was performed using a series (n=66) of bivariate mixed effects models and Residual Maximum Likelihood (REML) in ASReml (Gilmour *et al*., 2006), in which all combinations of discipline and grade were fitted in turn. Heritabilities of the 12 traits, genetic correlations, rider and horse permanent environment correlations were estimated.

Results
19829 horses competed in a total of 6875 competitions. The total number of records was 345067 but eliminations during the competition resulted in less records for show jumping (n=330092) and cross-country (n=301320). 3017 sires were represented and 11841 riders. Heritabilities for all grades in all disciplines were significant, with the exception of cross-country advanced and intermediate (Table 1). Heritabilities for show jumping were highest (8.2-15.7%) followed by dressage (7.1–9.0%). Heritabilities for cross-country novice and prenovice were low (1.4%).
Within discipline, for dressage and show jumping individually, genetic correlations were high 0.63-0.99. Between disciplines, in general, genetic correlations were not significant, indicating that no discipline was a good predictor of success (due to genetics) in another discipline.
The rider explained approximately 25% of the total phenotypic variance for each of the dressage phases, and was highest in advanced. For show jumping and cross-country the rider explained approximately 10% of the phenotypic variance. The effect of the horse's permanent environment was also greatest for dressage (16 – 21% of total phenotypic variance). For show jumping and cross-country the permanent environmental variance was significant for most discipline-grades, accounting for 5 - 9% of total phenotypic variance.
Horse sex and age had significant effects on performance.

Table 1 Heritabilities for each of the discipline-grades

Discipline-grade	heritability (SE)
Dressage A	0.090 (0.041)*
Dressage I	0.071 (0.017)*
Dressage N	0.075 (0.012)*
Dressage P	0.083 (0.010)*
Show jumping A	0.157 (0.039)*
Show jumping I	0.082 (0.014)*
Show jumping N	0.096 (0.011)*
Show jumping P	0.100 (0.009)*
Cross-country A	0.026 (0.020)
Cross-country I	0.003 (0.005)
Cross-country N	0.014 (0.005)*
Cross-country P	0.014 (0.004)*

* indicates significant values

Conclusions
Heritabilities for each of the eventing disciplines at every grade were significant, with the exception of the highest grades of cross-country. Heritabilities for show-jumping were 8.2-15.7%, for dressage 7.1–9.0%, and for cross-country novice and prenovice were 1.4%. Therefore there is potential to select for performance in eventing in the horse population competing in GB.
Variance-covariance matrices have been estimated, ready for use by the industry for prediction of breeding values. This will enable a multivariate analysis of all traits, yielding 12 breeding values for each horse. It is recommended that values are incorporated into an index value - overall, or possibly for each discipline - although all 12 values could potentially be presented. The advantages of this approach are that all information is included and that breeding values will be predicted for all discipline-grades irrespective of whether the horse has competed at that grade or not (based on genetic correlations between grades and performance of relatives).

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References
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